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Designing laboratory rainfall simulation experiments to examine the effects of a layer of vegetative ash on soil hydrology in Mediterranean areas

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Vegetative ash formed during forest wildfires often blankets the ground. Some studies have found the ash layer to increases infiltration by storing rainfall and protecting the underlying soil from sealing (Cerdà and Doerr, 2008; Woods and Balfour, 2008), but at the same time, others identified it as a potential cause of increased overland flow due to sealing the soil pores or crusting (Mallik et al., 1984; Onda et al., 2008). The variability in the effects of ash depends mainly on the ash type and temperature of combustion, ash thickness and soil type (Kinner and Moody, 2007; Larsen et al., 2009). In order to study the effect of the ash layer on the soil hydrology and soil erosion under i) intense thunderstorms, ii) wettable and water repellent soil and iii) different ash thicknesses, rainfall simulation experiments were performed in a small plot (0.09 m2) in order to reach the highest accuracy. The simulator comprises a constant head tank of 40x40 cm with 190 hypodermic needles of 0.5 mm. A randomization screen served to break up the raindrops and ensure random drop landing positions (Kamphorst, 1987). The average of the intensities applied in the experiment was 82.5 $\pm$ 4.13 mm h-1 during 40 minutes. In order to verify the constancy of the intensity it was measured before and after each simulation. The rainfall was conducted in a metal box of 30x30 cm within 1 m of distance from the randomization screen. The slope of the box was set at 10° (17%). It is designed to collect overland flow and subsurface flow through the soil. Each rainfall simulation was conducted on 3 cm of both wettable and water repellent soil (WDPT>7200s). They are the same soil but one transformed into hydrophobic. The treatments carried out are: a) bare soil, b) 5 mm of ash depth, c) 15 mm of ash depth and d) 30 mm of ash depth, with three replicates. The ash was collected from a wildfire and the thicknesses are in the range of the reported in the literature. The first replicate was used for analysis of water repellency, infiltration pattern and ash incorporation into the soil and the other replicates are used for a second rainfall, one after 24 hours and the other after being dried 4 days in the oven at 25ºC. In total there were 40 simulations. Overland flow and subsurface drainage were collected at 1-minute intervals and the forms was stored every 5 min to allow determination of sediment concentrations, yield and erosion rates. The experiment was completed with the installation of two moisture sensors at 1.5 cm of the soil and four splash cups that allowed determining the splash detachment at the end on the simulation. The importance in this series of experiments is the reproducibility and comparison of the different thicknesses of ash with the wettable and repellent soil. The results demonstrate that ash is a key factor on the post-fire soil erosion and hydrology and that rainfall simulation is a key tool to improve knowledge on low frequency – high magnitude events.

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